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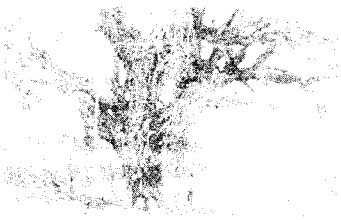

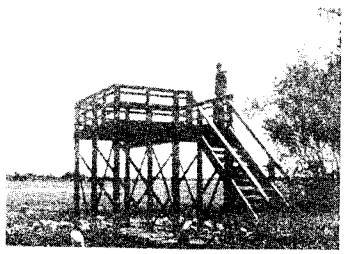

ENVIRONMENTAL LABORATORY

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TECHNICAL REPORT EL-87-7

AVIAN TERRITORY MAPPING

Section 6.3.4, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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October 1987
Final Report

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000
Under EIRP Work Unit 32420

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION
Unclassified

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

3. DISTRIBUTION/AVAILABILITY OF REPORT
Approved for public release, distribution unlimited.

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE

4. PERFORMING ORGANIZATION REPORT NUMBER(S)
Technical Report EL-87-7

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
USAEWES
Environmental Laboratory

6b. OFFICE SYMBOL (If applicable)

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS (City, State, and ZIP Code)
PO Box 631
Vicksburg, MS 39180-0631

7b. ADDRESS (City, State, and ZIP Code)

8a. NAME OF FUNDING/SPONSORING ORGANIZATION
US Army Corps of Engineers

8b. OFFICE SYMBOL (If applicable)

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS (City, State, and ZIP Code)
Washington, DC 20314-1000

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
			EIRP 32420

11. TITLE (Include Security Classification)
Avian Territory Mapping: Section 6.3.4,
US Army Corps of Engineers Wildlife Resources Management Manual

12. PERSONAL AUTHOR(S)
Wakeley, James S.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final report	FROM _____ TO _____	October 1987	16

16. SUPPLEMENTARY NOTATION
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Avian survey and sampling
Bird populations
Population estimation
Territorial behavior
Territory mapping
Wildlife management

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report on avian territory mapping is provided as Section 6.3.4 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report is designed to assist the District or project biologist in the application of territory mapping to estimate the density and diversity of breeding bird populations for planning, management, and research purposes.

The mapping method involves repeated visits to a relatively small study plot where observations of territorial songbirds are recorded on gridded maps. For each species, population density is determined by counting the number of occupied territories. The report presents guidelines concerning plot size and shape, plot maps, number of visits, survey timing and procedures, and interpretation of results.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION
Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL

22b. TELEPHONE (Include Area Code)

22c. OFFICE SYMBOL

DD Form 1473, JUN 86 *Previous editions are obsolete.*

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 32420, entitled Development of US Army Corps of Engineers Wildlife Resources Management Manual. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. David Mathis, Water Resources Support Center.

This report was prepared by Dr. James S. Wakeley, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, WTHG, was principal investigator for the work unit. Manuscript review was provided by Mr. Martin, Mr. James W. Teaford, and Dr. Wilma A. Mitchell, WTHG.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Information Products Division (IPD). Drawings were prepared by Mr. Alan L. Middleton, Engineering Graphics and Cartographic Section, IPD, under the supervision of Mr. G. Randy Crist.

COL Dwayne G. Lee, CE, was the Commander and Director of WES. Dr. Robert W. Whalin was Technical Director.

This report should be cited as follows:

Wakeley, James S. 1987. "Avian Territory Mapping: Section 6.3.4, US Army Corps of Engineers Wildlife Resources Management Manual," Technical Report EL-87-7, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

NOTE TO READER

This report is designated as Section 6.3.4 in Chapter 6 -- CENSUS AND SAMPLING TECHNIQUES, Part 6.3 -- BIRD SURVEY/CENSUS TECHNIQUES, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 6.

AVIAN TERRITORY MAPPING

Section 6.3.4, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

Territory mapping, also called spot mapping or simply "the mapping method," is considered by many ornithologists to be the most accurate and reliable method for determining the density of a bird population. Many investigators treat the results of mapping as a true census, or total count, of a population. Consequently, the method is often used as a standard against which other techniques are evaluated. However, mapping can be costly in both time and effort, which makes the method suitable only for intensive surveys of small study areas.

Mapping censuses are done during the breeding season, when most terrestrial bird species establish and defend territories that contain the nest site and feeding areas. For these species, population density can be determined by counting the number of occupied territories in a circumscribed area. The technique is widely used to estimate the abundance of songbirds, woodpeckers, and owls but is not suitable for counting waterfowl, seabirds, or colonial species.

A mapping census involves repeated visits to a relatively small study plot (usually 10 to 100 ha [25 to 250 acres]) where observations of territorial birds are recorded on gridded maps. Data are accumulated over a period of days or weeks until the plotted locations of each species resolve themselves into clusters of points that can be interpreted as centers of activity of individual territorial birds (Verner 1985). In most applications only the

number of territorial males is determined; this value is sometimes multiplied by 2 to include their less conspicuous mates. Counts for each species can be converted to densities and can also be used to calculate diversity indices.

The most ambitious and widespread use of territory mapping in North America is the Breeding Bird Census sponsored by the National Audubon Society. Dozens of individual censuses are accomplished each year by volunteer cooperators across the United States and Canada. The results have been published annually in American Birds (formerly Audubon Field Notes) since 1937, and provide a valuable information base with which to study the changing distribution patterns of breeding birds and the long-term effects of land-use changes on the American avifauna.

PROCEDURE

The procedure for territory mapping has been standardized by the International Bird Census Committee (IBCC) to reduce sampling problems and facilitate comparisons between different study areas and habitat types. Much of the following information is summarized from IBCC recommendations (Robbins 1970).

The Study Plot

The study plot should be square, or nearly so, to minimize the length of its perimeter and reduce the number of borderline territories that are partly in and partly outside the plot. Sampling errors are greatest on small or narrow tracts (Hall 1964). Although it is not critical to the method, interpretation is simpler if the plot is situated in fairly homogeneous vegetation with a wide surrounding zone of the same cover type. This reduces problems associated with the edge effect, in which bird species may concentrate along the interface between different cover types. For example, a forested study plot adjacent to open fields will contain many species that are not true forest birds and are only present on the plot because of its proximity to the adjoining habitat.

The IBCC recommends a plot size of at least 40 ha (100 acres) (i.e., a square 632 m [2087 ft] on a side) in an open habitat, such as grassland or old field, and 10 ha (25 acres) (i.e., a square 316 m [1044 ft] on a side) in a closed habitat, such as a forest. The greater the plot area, the more bird species it is likely to contain. Engstrom (1981) found that a 25-ha (62-acre) plot in uniform pine habitat contained only 80% of the bird species found on a

58-ha (144-acre) plot at the same location. By using larger plots, the investigator can detect more species, obtain more accurate density estimates for the less common species, and reduce the length of the perimeter per unit of plot area. Therefore, the plot should be as large as the investigator can handle efficiently.

The plot should be marked on the ground with a system of numbered grid points to allow the observer to pinpoint his own position and that of the birds he sees. A surveyor's transit and chain, or a good compass and careful pacing, should be used to establish the grid. The IBCC recommends a grid size of 100 × 100 m (328 × 328 ft) in open habitats and 50 × 50 m (164 × 164 ft) in closed habitats. It should also be possible to move freely between points, perhaps by establishing cleared paths through the vegetation.

An important part of many territory-mapping studies is a description of vegetation on the study plot. This is particularly useful in comparative studies where differences in habitat characteristics may help to explain differences in bird densities or species composition between plots. One widely used method of vegetation description is that of James and Shugart (1970), which is recommended to participants in the Breeding Bird Census by the editors of American Birds. This method provides information on ground cover, canopy cover, shrub density, canopy height, and the density, basal area, and frequency of trees. Additional techniques for vegetation sampling are given in Section 6.2 of this manual.

Plot Maps

A base map of the study plot should be prepared that indicates plot boundaries, grid marks, and topography or physical features (e.g., rock outcrops, fences, vegetation changes) that will help to orient the observer. A separate map (visit map) is needed to record observations of birds each time the study plot is visited. Additional maps (species maps) are used to compile cumulative observations for each species encountered on the plot over the length of the study. A simple outline map is best because it can be photocopied to make multiple species and visit maps. Because visit maps must be taken into the field, they should be photocopied in convenient sections that will fit a clipboard or field notebook. Visit maps should also include space for the plot identification, date, beginning and ending times of the visit, starting and ending points, name of the observer, and weather conditions. A

map scale of 1:1250 to 1:2500 (1 cm:12.5 m to 1 cm:25 m) is recommended by the IBCC for plots in woodland habitats and 1:2000 to 1:5000 (1 cm:20 m to 1 cm:50 m) for those in open habitats. Even larger scales may be preferable to keep the maps from becoming hopelessly cluttered, particularly in areas with high bird densities.

Number of Visits

Occupied territories are delineated on each species map by identifying clusters of observations that accumulate over time. Therefore, several visits to the plot are required to gather sufficient data. Kendeigh (1944) used 6 visits to census forest birds on 8.5 ha (21 acres) of hemlock-beech forest in New York and found that the number of species increased with an increasing number of visits. Only 49% of the eventual total number of species were counted during the first visit; 63% were counted in 2 visits, 76% in 3 visits, 92% in 4 visits, and 96% in 5 visits. The IBCC recommends that a census consist of at least 10 visits to a closed habitat and 8 visits to an open habitat. Visits should be spaced at regular intervals with no more than 1 visit per day.

Survey Timing and Routes

There is no best time of year to do a mapping census because different bird species breed at different times, and timing varies geographically. However, visits should be scheduled to coincide with the peak of territorial activity in a given area and should be accomplished in the shortest period that includes the breeding times of the majority of species. Minimizing the length of the census period reduces problems in interpreting the data resulting from territory abandonment and other changes during the study. Conversely, extension of the sampling period may be necessary to gather enough information on early- or late-nesting species. Breeding bird censuses reported in American Birds typically are completed during a period of 3 to 8 weeks.

Individual visits should be made in the morning, preferably in the first 3 to 4 hours after sunrise if that allows sufficient time to cover the plot. This is the time when singing is normally at its peak and most birds are relatively easy to detect. Site visits should be made on calm days with no rain to maximize the opportunity to hear bird songs and calls.

The route of passage through the plot should be varied on each visit so that each portion of the area will be visited at different hours through the census period. On any visit, no part of the plot should be farther than 50 m (164 ft) from the route in a closed habitat or more than 100 m (328 ft) from it in an open habitat. The survey route should extend all the way to the plot boundary so that borderline territories can be mapped.

Data Collection

The observer walks slowly along the survey route and records all sight or sound contacts with birds, paying particular attention to those with possible territorial significance, such as singing, chasing, and fighting. The majority of contacts in most studies will be by sound. Therefore, it is a good idea to learn or review the songs and call notes of local species before starting a mapping study. A small hand-held tape recorder is useful to record questionable calls in the field so they can be verified later.

Contacts are recorded directly on the visit map (Fig. 1) by writing the abbreviated species name along with a symbol representing the bird's activity when it was detected. To minimize clutter on the visit map, abbreviations should consist of only 1 or 2 letters. A symbol for sex or age can be added if appropriate, and the time of the sighting may help to track moving birds. The IBCC recommends the standard symbols for bird activities given in Figure 2. Additional clarifying notes can also be written on the map.

Interpretation

After each visit to the study plot, the investigator transfers locations of bird contacts from the visit map to the appropriate species maps, and each contact is numbered or color-coded according to the visit on which it was made (Hall 1964, Robbins 1978). A hypothetical species map for rufous-sided towhees (*Pipilo erythrophthalmus*) is shown in Figure 3. Notice that this species map includes information from the visit map for day 5, shown in Figure 1.

Territories are delineated on the species maps by identifying clusters of contacts that belong to different individual males or family groups. The procedure can be highly subjective, particularly if territories are closely packed. However, certain behaviors, such as simultaneous singing or aggressive encounters between 2 males, are strong evidence for the presence of separate territories (Fig. 3). A cluster should be counted as a territory if it consists of at least 3 contacts of which 2 have territorial significance. In

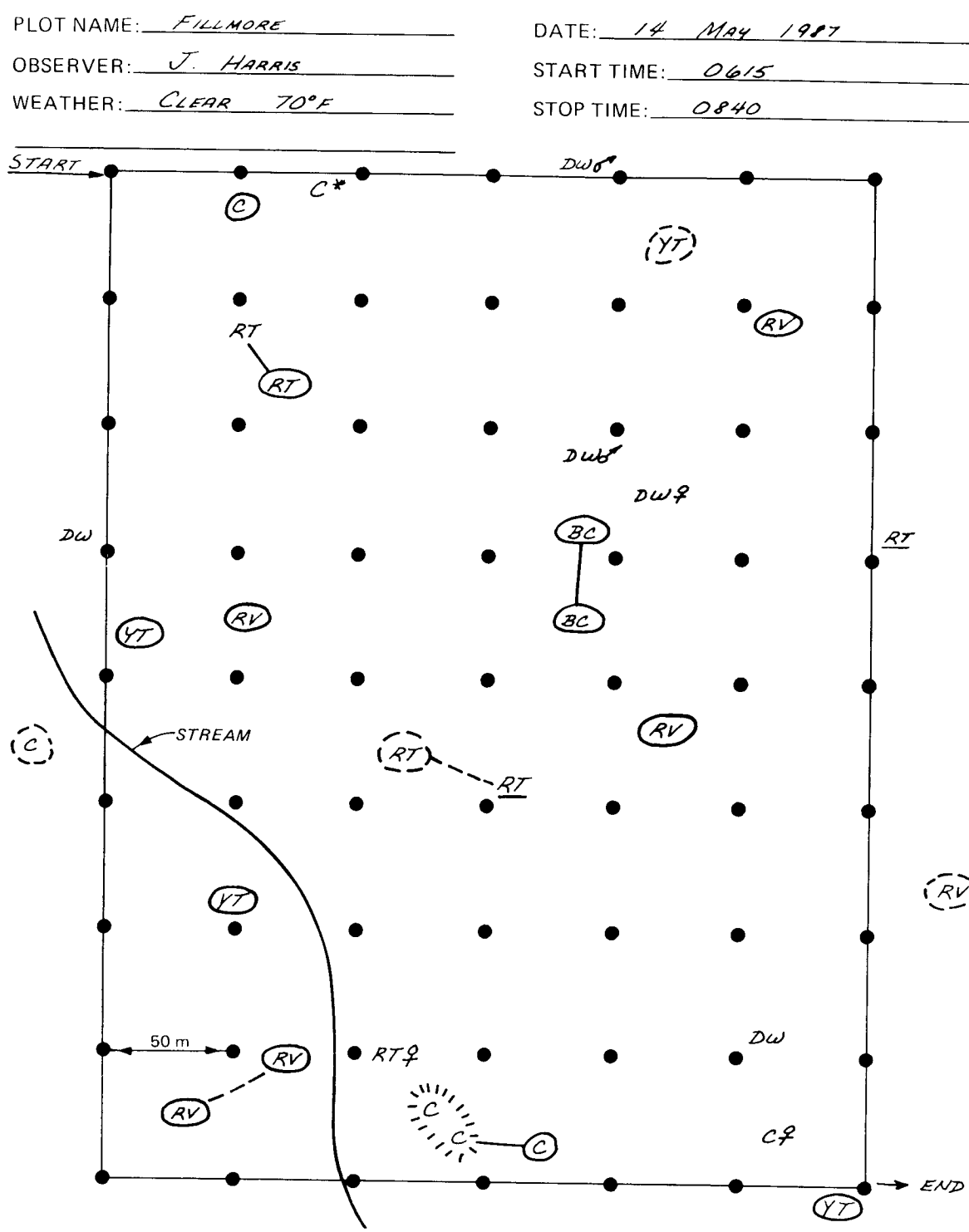

Figure 1. Visit map to a hypothetical 12-ha study area on day 5 of a territory-mapping survey. Standard symbols for bird activities are explained in Figure 2. Bird species are indicated as follows: BC, black-billed cuckoo (*Coccyzus erythropthalmus*); DW, downy woodpecker (*Picoides pubescens*); RT, rufous-sided towhee (*Pipilo erythrophthalmus*); C, northern cardinal (*Cardinalis cardinalis*); RV, red-eyed vireo (*Vireo olivaceus*); and YT, common yellowthroat (*Geothlypis trichas*)

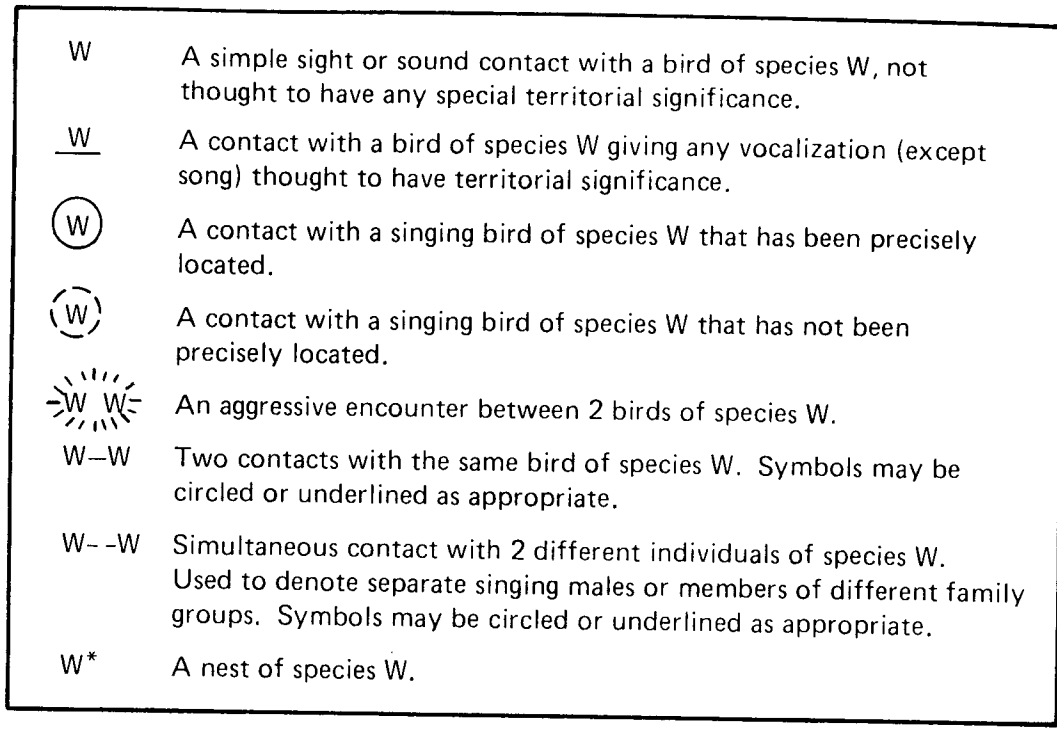

Figure 2. Standard symbols for bird activities recommended by the International Bird Census Committee

equivocal cases, the investigator must be guided by logic and a knowledge of the territorial behavior of the species involved. It is not critical that territories be delineated exactly; only the number of territories is important. It is generally best to be conservative and use the smallest number of territories that can be developed from the mapped locations.

For territories that overlap the boundary of the study plot, the IBCC recommends counting only those in which more than 1/2 the contacts lie within the plot boundary. However, the system followed by American Birds is to count fractional territories within the plot and round to the nearest half-territory. Population size is reported as the number of adult males on the plot (i.e., number of mapped territories); for species having 3 or more territories on the plot, it is expressed as density of males in some standard area (e.g., males/100 ha).

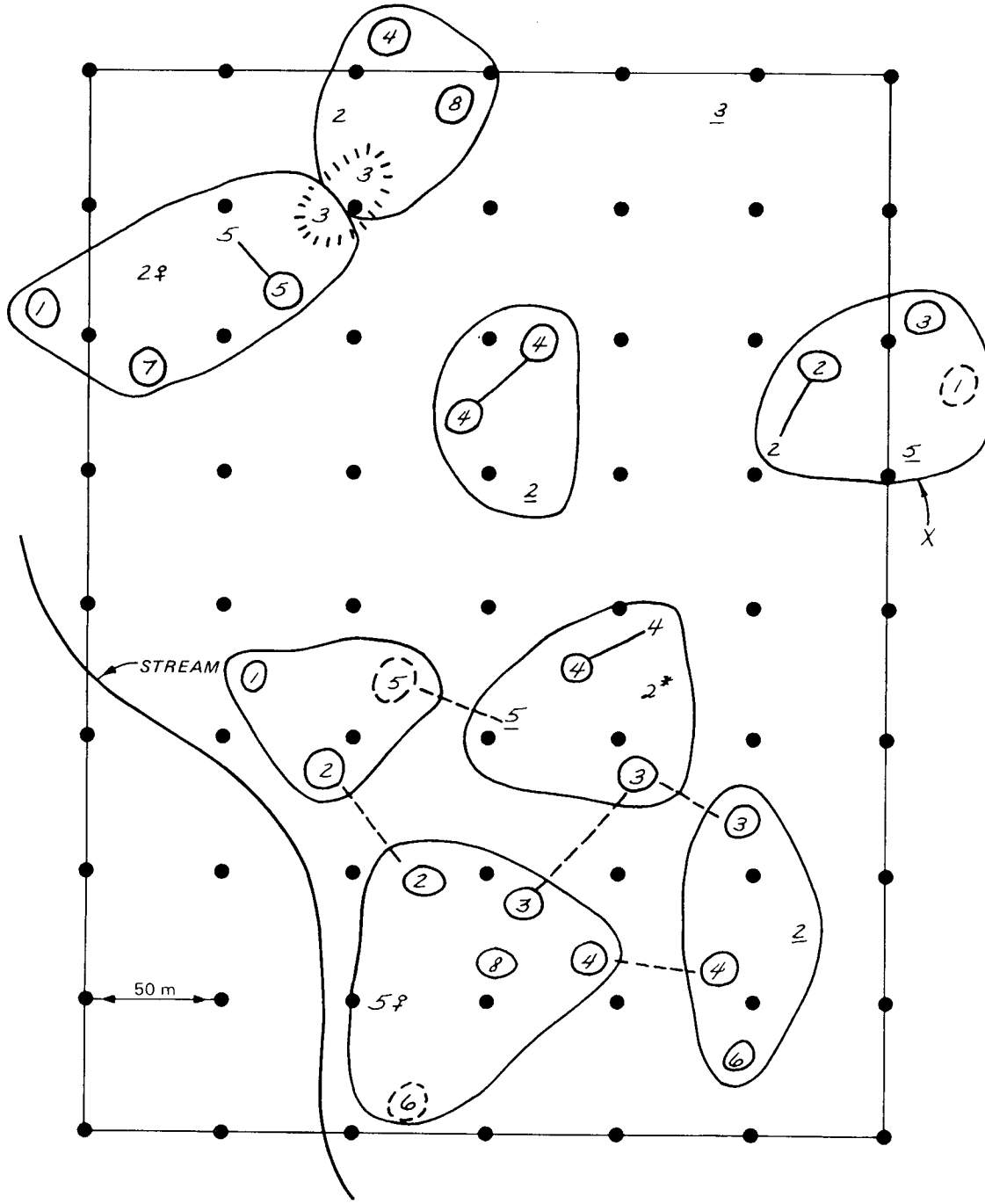

Figure 3. Territories of rufous-sided towhees as indicated by sight and sound contacts accumulated during 8 visits to a 12-ha study plot. Numbers indicate the site visit. Note that 3 territories lie partly outside the plot boundary. There are 7 territories on the plot, giving a density of 58.3 males/ 100 ha. (The cluster marked with an X was not included because more than one-half of the contacts lie outside the study plot.)

CONSECUTIVE-FLUSH TECHNIQUE

The consecutive-flush technique is a variation of territory mapping that may be useful in open habitats, such as grasslands or steppes, where the localized movements of a bird within its territory can be followed easily (Verner 1985). The procedure is to approach a singing bird until it flushes and record its initial position, flight path, and landing spot on a gridded field map. This is done repeatedly until at least 20 consecutive flushes have been recorded. The bird's territory is represented by the area within which its movements occurred.

Consecutive flushing takes only a few minutes per bird, does not require repeated visits to the study area, and may give a more accurate indication of territory boundaries (Verner 1985). Because it can be done in a short time, it reduces uncertainty due to changes in territory occupancy; however, the procedure may have to be repeated to sample both early- and late-nesting species. Occasional flushing can be useful as a supplement to a standard territory-mapping project even in forests or other densely vegetated habitats, by helping to interpret clusters of observations.

CAUTIONS AND LIMITATIONS

A pilot study on a small area is recommended for anyone considering a territory-mapping project. Experience is invaluable to reduce confusion and increase sampling efficiency. First-time users may experience problems sorting out birds that call simultaneously, determining the location of birds that are heard but not seen, or completing visits in a reasonable period of time. It is also helpful to be thoroughly familiar with the procedure for recording data before tackling a major project.

One shortcoming of the mapping method is that only territorial males of most species are countable. Females, juveniles, and nonterritorial birds are not detected consistently enough to map their activity centers. In monogamous species the presence of females is sometimes accounted for by multiplying the number of males by 2, but this does not allow for unmated males. For example, Kendeigh (1944) found that 9% of territorial house wrens (*Troglodytes aedon*) lacked mates. A mapping survey is further complicated by changes in territory boundaries during the census and the territorial behavior of migrants (Oelke 1981). The latter is a particular problem in the South where migrants

may still be passing through during the peak of breeding; their singing can complicate the count.

Territory mapping works best with species that are highly detectable. If there is at least a 50% probability of detecting a bird on any particular visit, more than 90% of territories should be identified in 10 visits to the plot. With a 30% probability of detection, only about 55% of the territories will be identified (Verner 1985). Additional visits to the plot can compensate to some extent for low detectability, but this also increases the chances of spurious clusters resulting from detections of transients and territorial birds off their territories. Verner (1985) suggested that 8 to 14 visits offer the best compromise.

Plotting of territories can be a highly subjective exercise, which is made even more difficult by the extreme areas occupied by some species or by the presence of many closely packed territories. Best (1975) showed that various interpretations of the same mapping data are possible and that personal experience may be important in interpretation. Therefore, mapping studies should be carried out and the data interpreted by one person whenever possible.

Most researchers treat the results of a carefully performed mapping survey as though it were a total count of a bird population (at least of males), for which an estimate of variance is unnecessary. However, Eagles (1981) argued that territory mapping actually provides only one very elaborate cumulative sample of the population. Therefore, there is a statistical error associated with that sample equal to the difference between the number of mapped territories and the actual number of territories on the plot. He points out that this error can be evaluated only by taking complete replicate surveys of the same plot.

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